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### (54) Balloon catheter and method for manufacturing it

(57) The invention relates to a balloon catheter comprising a catheter tube and an inflatable balloon, the ends of which being attached to the catheter tube, whereby the outside surface of the balloon in an unin-

flated state is provided with a relief structure which in an inflated state of the balloon is substantially disappeared; as well as a method for producing such a balloon catheter.

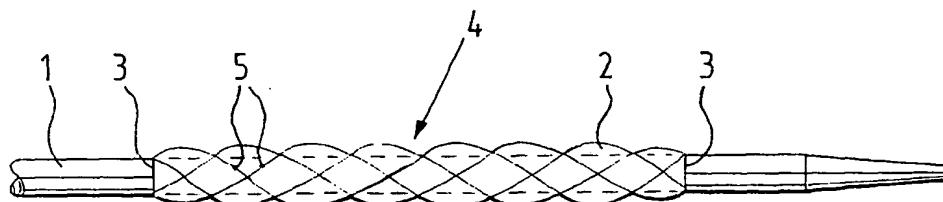


FIG. 2A

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**Description**

**[0001]** The present invention relates to a balloon catheter comprising a catheter tube and an inflatable balloon which at its ends is attached to the catheter tube. The invention further relates to a method of manufacturing a balloon catheter.

**[0002]** Balloon catheters of this type are generally known and are used for dilating vessels and lumina. In order to pass the balloon catheter easily and safely through the vessels and lumina and to position it at the required place for dilatation, it is important that the balloon catheter has a small profile and is sufficiently flexible.

**[0003]** The object of the invention is therefore to provide an improved balloon catheter.

**[0004]** The balloon catheter according to the invention is characterized in that the outside surface of the balloon in an uninflated state is provided with a relief structure which in an inflated state of the balloon is substantially disappeared.

**[0005]** Tests have shown that with a relief structure on the outside surface of the balloon, a catheter is obtained that is more flexible than a standard balloon catheter. The balloon catheter according to the invention can therefore be passed more easily and more safely through vessels and lumina to the point of dilatation. Because of its flexibility, the catheter will be able to adapt better to a bend in a vessel or a lumen, thus reducing the risk of damage to the vessel or lumen.

**[0006]** The required relief structure may have different embodiments, but preferably comprises at least one groove that extends at least transversely in the longitudinal direction of the balloon in order to give the catheter the required flexibility in a direction transverse to the longitudinal direction thereof.

**[0007]** The groove preferably extends at a predetermined angle with respect to the longitudinal direction of the balloon. While according to a preferred embodiment the groove extends helically from one end to the other end of the balloon, over the outside surface thereof.

**[0008]** According to another embodiment, the relief structure comprises two or more grooves that extend helically from one end to the other end of the balloon, crossing each other. Tests have shown that with such a relief structure a very flexible balloon catheter is obtained which also has a relatively small profile.

**[0009]** The invention also relates to a method for producing a balloon catheter consisting of attaching the ends of an inflatable balloon to a catheter tube, whereby according to the invention the outside surface of the balloon is provided with a relief structure.

**[0010]** According to an embodiment of the invention, the relief structure is produced on the application of heat in order to deform the elastic material of the balloon.

**[0011]** The relief structure is also preferably produced on the surface of the balloon by applying a high pressure to the inside of the balloon.

**[0012]** According to a very inexpensive method, the relief structure is produced on the surface of the balloon by winding a wire around the balloon in the form of a helix.

**[0013]** According to another simple method, the relief structure is produced on the surface of the balloon by taking up the balloon in a counter-pressure body that has the relief structure.

**[0014]** The invention is explained in more detail on the basis of the drawings attached. The drawings show:

Figure 1A is a side view of a first embodiment of a balloon catheter in an uninflated state;

Figure 1B is a side view of the catheter in Figure 1A in an inflated state, and

Figure 2A is a side view of a second embodiment of a balloon catheter in an uninflated state, and

Figure 2B is a side view of the catheter of Figure 2A in an inflated state.

**[0015]** A balloon catheter according to the invention comprises a catheter tube 1 and an inflatable balloon 2, which at its ends is attached to the catheter tube 1. In an uninflated state (Figures 1A and 2A), the outside surface of balloon 2 has a relief structure 4 that in the inflated state has virtually or completely disappeared (Figures 1B and 2B). The relief structure gives the catheter its required flexibility.

**[0016]** In the first embodiment according to Figures

1A and 1B, the relief structure 4 consists of one groove 5, which extends helically from one end 3 to the other end 3 of the balloon 2, over the outside surface thereof. The uninflated balloon 2 has thereby obtained a helical relief surface. In the second embodiment according to Figures 2A and 2B, the relief structure 4 consists of two grooves 5,6, which extend helically from one end 3 to the other end 3 of the balloon 2 and thereby cross each other. The uninflated balloon 2 has hereby obtained a padded relief surface.

**[0017]** Other relief structures are of course possible, provided that the relief structure on the catheter creates the necessary flexibility in a direction transverse to the longitudinal direction of the balloon.

**[0018]** One way of obtaining the relief structure as shown in the drawings is by winding a wire helically around the balloon 2. If the wire is wound only in the forward direction, the structure according to Figure 1A is obtained, and if the wire is also wound in the return direction, the structure in Figure 2A is obtained. After

the wire has been wound around the balloon, a sleeve is pulled over the balloon. Subsequently, with the application of raised pressure to the inside of the balloon, the balloon is heated in such a way that, in an uninflated state, the balloon obtains a relief structure that on dilating of the balloon at the dilatation site in the vessel or lumen will virtually or completely disappear. The sleeve is then removed and the balloon catheter can be inserted into a vessel or a lumen.

[0019] Instead of winding a wire, the balloon may be placed in a mould, which is provided with the relief pattern required in order for it to obtain, under raised pressure and temperature, the relief structure required.

[0020] Before the balloon is provided with its relief structure, preferably it is folded in the usual way in order to reduce its profile. By applying the relief structure, the profile will be reduced still further as an additional, advantageous effect.

[0021] Note that, although it is not shown in the drawings, it is possible to provide the outside surface of the balloon with various helical grooves that cross each other.

loon by winding a wire helically around the balloon.

- 10 5 10  
10. Method according to one of claims 6-9, whereby the relief structure is applied to the surface of the balloon by taking up the balloon in a counter-pressure body provided with the relief structure.

### Claims

1. Balloon catheter comprising a catheter tube and an inflatable balloon, the ends of which being attached to the catheter tube, characterized in that in an uninflated state the outside surface of the balloon is provided with a relief structure, which is substantially disappeared in an inflated state of the balloon.
2. Catheter according to claim 1, whereby the relief structure comprises at least one groove that extends at least transversely in the longitudinal direction of the balloon.
3. Catheter according to claim 2, whereby the groove extends at a predetermined angle with regard to the longitudinal direction of the balloon.
4. Catheter according to claims 2 and 3, whereby the groove extends helically from one end to the other end of the balloon, over the outside surface thereof.
5. Catheter according to claims 2, 3 and 4, whereby the relief structure comprises two or more grooves that extend helically from one end to the other end of the balloon and cross each other.
6. Method for producing a balloon catheter comprising the attaching of the ends of an inflatable balloon to a catheter tube, whereby the outside surface of the balloon is provided with a relief structure.
7. Method according to claim 6, whereby the relief structure is applied to the surface of the balloon under the application of heat.
8. Method according to claims 6 or 7, whereby the relief structure is applied to the surface of the balloon under the application of raised pressure to the inside of the balloon.
9. Method according to one of claims 6-8, whereby the relief structure is applied to the surface of the bal-

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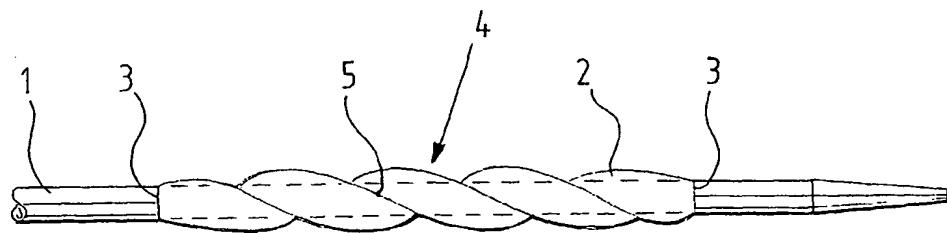


FIG. 1A

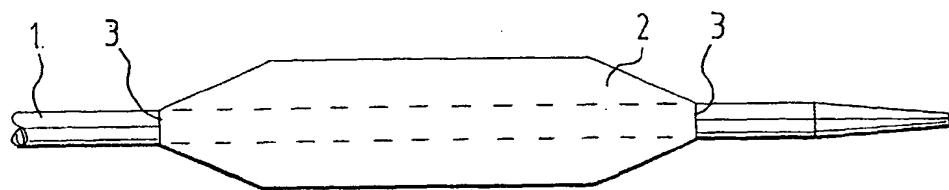


FIG. 1B

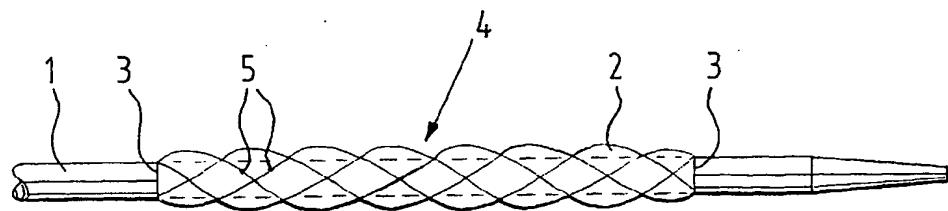


FIG. 2A

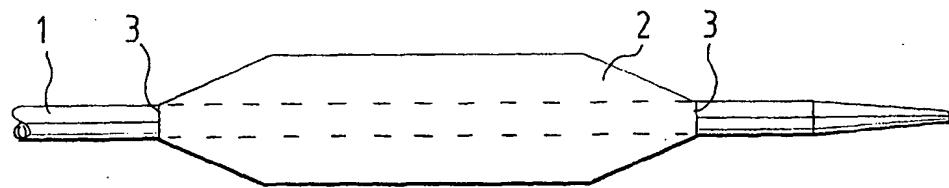


FIG. 2B

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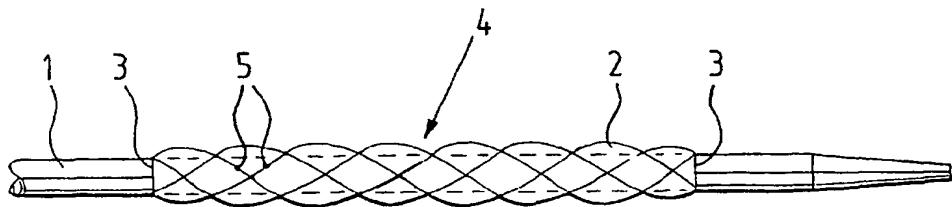


FIG. 2A

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## EUROPEAN SEARCH REPORT

Application Number  
EP 02 07 6819

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X	US 5 891 386 A (DEITERMANN MORRIS H ET AL) 6 April 1999 (1999-04-06) * column 3, line 65 - column 6, line 27; figures *	1-4,6-10	
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A	US 5 295 959 A (GURBEL PAUL A ET AL) 22 March 1994 (1994-03-22) * column 11, line 13 - column 12, line 45; figures *	1-10	
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The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	14 November 2003	Kousouretas, I	
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 02 07 6819

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